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Dispersive Wave Processing: A Model-Based Solution

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Wave propagation through various media represents a significant problem in many applications in acoustics and electromagnetics especially when the medium is dispersive. The propagation of sound in the ever changing ocean environment is a problem made quite evident in submarine detection and localization, while exploration seismologists constantly struggle with the question of oil reservoir location through sonic measurements in a borehole. Electromagnetic wave propagation through the ionosphere in radio direction finding is also a problem due to the rapidly changing environmental conditions. Therefore, we pose a general dispersive wave propagation model that could easily represent many classes of dispersive waves and proceed to develop a model-based processor employing this underlying structure. The general solution to the model-based dispersive wave estimation problem is developed using the Bayesian maximum a-posteriori (MAP) approach and shown to lead to the nonlinear extended Kalman filter (EKF) processor. Next, the problem of internal wave estimation is cast within this framework, the specific processor is developed and applied to data synthesized by a sophisticated simulator demonstrating the feasibility of this approach.

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